09/719413
526 Rec'd PCT/PTO 12 DEC 2000

A method and a mobile station for configuring a base station.

The object of the invention is to present a method for configuring an indoor cellular base station and an arrangement where this method is implemented.

In figure 1 a known method to install and configure cellular Base Transceiver Stations is shown. Digital maps of the building and a database describing positions of external antennas are first edited in step 1. The indoor network for the building is planned in step 2 using a network planning tool with the data acquired in the previous phase. The base stations that are allocated to the building are installed and configured in step 3 using the planned parameters. When the base stations are activated the performance of the indoor network is measured in step 4. If the performance is found acceptable in step 5, the installing and configuring of the base stations is ended. If any correctable errors are found in step 5, the procedure is repeated from step 2 using the data obtained from the measurements. Additional base stations are installed and/or different configuration parameters experimented with in step 3. The performance of the resulting configuration is measured in step 4 and compared in step 5 to the desired performance. The procedure is repeated from step 2 until an acceptable result is obtained.

One problem in the configuration of base stations according to the prior art is the time required to configure a station for the specific installation area, for example an apartment in a building. The prior art methods used are time consuming, since simulation is typically used for finding correct operation parameters for the base station. Further, extensive measurement campaigns are typically performed for finding the optimum locations for the base stations. As a result, installation time for a base station may be up to 8 days.

An object of the invention is to present a better and easier method for configuring an indoor base station in a building. A further object of the invention is to provide a method, which requres considerably less installation time needed for installation of a single base station.

This is achieved by active use of a mobile communications means as a frequency scanner and using the results of the scanning in the configuration of correct base station parameters.

The invention concerns a method for configuring a base station. The method according to the invention is characterized in that, which is specified in the characterizing part of the independent claim directed to a method.

The invention is further directed to a mobile station for configuring a base station of a cellular telecommunications network. The mobile station according to the invention is characterized in that, which is specified in the characterizing part of the independent claim directed to a mobile station.

Preferred embodiments of the invention are presented in the dependent claims.

The present invention allows configuring of an indoor base station with less planning than according to prior art methods. Suitable places for the stations are first located by a rough inspection of the building, whereafter the stations are installed and wired by an installation engineer. The base stations are configured using a mobile communication means for both scanning the frequencies and communicating the results of the scanning to the base station. An advantage of the invention is, that the invention allows obtaining free frequencies on-site for the base stations to operate on and after selecting a sufficient amount of frequencies, uploading the selections to the base stations. Theoretical calculations are not necessarily needed for finding frequencies that are free enough from the effect of

the external network outside the building. The means used for scanning and selecting the frequencies can be made easy to use. In an advantageous embodiment of the invention, no manual setting of frequencies for the base station is needed because of automated data exchance between the scanning means and the base station. Configuring of a base station with the inventive method and arrangement is much faster compared to prior art methods. Configuration time can be shortened as long as about 8 days according to the prior art methods to as low as 1 hour using the inventive method.

The invention is described in detail in the following by referring to the attached drawings, in which

figure 1 presents a prior art method to configure a base station,

figure 2 presents a method according to an advantageous embodiment of the invention in a flow chart,

figure 3 presents a block diagram of an advantageous embodiment of the invention, and

figure 4 presents a block diagram of a mobile station according to one advantageous embodiment of the invention.

Figure 1 was described previously in connection with description of prior art.

In one advantageous embodiment of the invention, installation of an indoor cellular network proceeds in the following four phases. This embodiment is illustrated by figure 2.

1. Preparation of the building

In the first phase 11, the building is roughly inspected, if possible. Based on the inspection and maps of the building, preliminary locations for base stations are located. Preferably, a slightly larger number of preliminary locations are preplanned than will actually be used. Some locations are preferably prepared near entrances to the building to form a gateway to surrounding cellular network. Sufficient overlap with the surrounding network is necessary to allow smooth handover of connections

from the in-building network to the surrounding network and vice versa. A data transmission network is constructed in the building based on these preplanned preliminary locations. For example, existing telephone wiring can be used for construction of the data transmission network. Any necessary network elements for creating the data transmission network in addition to the wiring are installed at this phase.

2. Preparation of parameters

At the second phase 12, default parameter sets, cell identifiers, base station identifiers and any other eventual necessary base station setup information are assigned to each location. A frequency band is selected for the indoor cellular system. The frequency band may be, for example, a dedicated office band or the whole band of the particular network operator. All this information is downloaded to a mobile communication means of an installation engineer. Further, information describing the contents of the frequency band, i.e. frequencies used by the neighbouring external cellular system using the same frequency band is downloaded. Particularly, BCCH frequencies of the neighbouring cells are listed, along with corresponding TCH frequencies.

3. Installation of base stations

In the third phase, the base stations are installed and configured. At each installation location, an installation engineer scans 13 the chosen frequency band with said mobile communication means. The interference from an external network is typically strongest near windows, doors and other ports in walls. Preferably, the mobile communication means presents a spectrum display of measured signal levels within the frequency band, with BCCH and TCH frequencies of the neighbouring cells of the external network indicated in the same display. This allows the installation engineer to choose 14 an operation frequency for the base station, which frequency is free enough from outside interference. With the aid of the indicated BCCH frequencies and corresponding TCH frequencies of neighbouring cells, the engineer can avoid selecting a frequency, which is used as a TCH channel in a neighbouring cells. During a single measurement session, a neighbouring cell may have set the transmission level of the TCH channel relatively low, which would be seen as a low enough interference level inside of the building. However, since the transmission level of TCH channels is generally adjusted according to quality of

radio link to various mobile stations, at some another time the neighbouring cell may use considerably higher transmission power for the TCH channel. Therefore, the signal level of the corresponding BCCH frequency is preferably taken into account. Transmission power of BCCH channels is not varied, whereby observation of the signal level at a BCCH frequency gives the a better worst-case estimate of the level of interference at the TCH frequency of the same cell.

After selecting the frequency, the engineer selects the desired 15 parameter set according to the surroundings of the base station location and sets the power level of the base station. The power level and the parameter set can be changed afterwards if necessary, for example, if during actual use of the station it is found that a slightly different power level and/or parameter set is appropriate. The power level can preferably be selected from a plurality of different preset levels. Next, the engineer preferably installs 16 the base station into the location, connects it to data transmission and power lines, and switches the base station on. After the base station has performed any eventual power-on tests, the engineer inputs 17 the base station identification information to the base station. This may be proceeded using a keypad of the base station, for example, or by transmitting the information by an IR link or a cable from the mobile communication means to the base station. When the base station has received the identification information, it can perform the configuration of the transmission link between the base station and the corresponding base station controller (BSC) of the indoor cellular system.

When the transmission link between the base station and the BSC is ready for use, the rest of the configuration information is input to the base station. Preferably, this is performed by transmitting 18 the configuration information from the mobile communication means of the installation engineer to the BSC, which then configures 19 the base station according to the received configuration information. The transmission of the configuration information to the BSC may be effected, for example, via the base station using an IR link or a cable between the base station and the mobile communication means, or for example, using a data call through the external network between the mobile communication means and the network management system of the indoor cellular system. After the configuration, the indoor cellular network instructs the base station to be activated 20.

In another embodiment of the invention, the configuration data is transmitted to the network management system (NMS) of the indoor cellular system, which then

configures the base station. In such an embodiment, the BSC effectively only relays the configuration commands from the NMS to the base station.

Before transmission of the configuration data, the connection should in a preferable embodiment of the invention be authenticated by the indoor cellular network for security reasons.

The procedure of the third phase is repeated for each site. Since in the preplanning phase more sites were prepared than will most probably be needed, the installation engineer may leave some sites uninstalled according to his/her judgment, for example.

Preferably, the installing of the base stations is started from the gateway cells because the number of frequencies that are available decreases each time when a site is set up, whereafter there are fewer frequencies to choose from, and since designing of the necessary overlap between the external and indoor network requires more freedom in the selection of the frequencies than setting up of a single indoor base station.

4. Ensuring the functioning of the indoor network

In the fourth phase 21, after the base stations have been installed, the operation of the indoor network is checked. This can be performed by the installation engineer or engineers by moving in the building while having a connection to the network with the mobile communication means of the engineer. Preferably, the mobile communication means is equipped with means such as a program for monitoring the performance of the network. If locations having poor field strength are observed, more base stations can be installed to cover such coverage holes. Also, the operating parameters of the base stations may be adjusted at this phase.

Figure 3 illustrates an arrangement according to an advantageous embodiment of the invention. Mobile communications means 22 is used for the configuration of the Base Transceiver Station BTS 23 via an IR or a serial interface. BTS 23 is connected to a base station controller BSC 24 through an Abis interface. BSC 24 is used to set the parameters of the base station 23. BSC 24 is further connected to an Mobile Switching Centre MSC 25 through an A interface. The MSC 25 performs switching functions and other duties. BSC 24 is also connected to a Network

Management Station NMS 26 which is a part of the network supervision system. NMS 26 is used to control the network elements of the network. The mobile station MS 27 can be used for normal calls after the configuration of the base station 23.

The mobile communications means 22 is preferably a mobile phone with speech and data capabilities and a special program for controlling the scanning and input of the configuration information. The program obtains data from the NMS 26, controls measuring of the reception levels at the frequencies of the chosen frequency band, manages configuration parameters such as the power levels and other necessary parameters and controls sending of configuration data to the BTS 23. Preferably the application for measuring reception levels calculates averaged reception levels for the frequencies. The reception levels are preferably space averaged, which can be done for example by moving the mobile communication means around within the area of the base station site and averaging the measurement results obtained during the movement.

The BTS 23 can include control lights for indicating the status of the equipment. Different status indications can be for example the following: "just powered-on", "transmission line ready", "on-line but barred and no handovers", "on-line but barred" and "fully on-line".

Figure 4 shows a block diagram of a mobile station for configuring a base station according to an advantageous embodiment of the invention. A processor 41 is used for controlling frequency scanning, a memory 42 for storing a program for the processor 41, a receiver 45 and an antenna 46 for receiving on a plurality of frequencies, and transmitting means 47 for transmitting data based on frequency scanning to a base station. The mobile station also includes a display 43 for presenting menus and results of the frequency scanning and a keyboard 44 for inputting data as a frequency selection for the BTS. The transmitting means include an IR transmitter 47 and an IR light emitting diode 48 for transmitting data to the BTS.

In other embodiments of the invention, other transmission means such as a serial RS-232 line can be used to transmit the configuration information. However, the invention is not limited to these ways of transmitting the configuration information, since any other way of transmitting the configuration information may be used. For example, if the mobile communication means which is used for scanning is a dual

band device capable of operating in two different frequency bands, such as the 900 MHz GSM band and the 1800 MHz GSM band, the mobile communication means can scan the frequencies of a first of these two bands and transmit the configuration information on the second of these two bands to for example another mobile communication means connected to the BSC 24. In an another advantageous embodiment of the invention, the mobile communication means is used first to scan and store information, and after the scanning, to send the configuration data using the same frequency band via the outside cellular network to the BSC.

In a preferable embodiment of the invention, a multifunction mobile communication means is used for scanning the frequencies. A multifunction mobile communication means typically comprises elements needed for a cellular phone and a data processing part having a display and a keyboard for processing data transmitted using the cellular phone part. Such a multifunction mobile communication means is presented, for example, in the magazine Mobile Communications International, Issue no. 31, May 1996, on pages 57 and 58. According to an advantageous embodiment of the invention, such a multifunction mobile communication means is equipped with a program for controlling the scanning and performing other necessary tasks for base station configuration as described previously. The following example is presented to explain an advantageous embodiment of the invention. We assume that an office building of three floors is in an area having an external cellular network, and indoor base stations are to be installed in the building. First the building is visited to find out approximate number of the base stations needed and the locations for the base stations. The entrance corridor of the building must have some gateway cells and all rooms separated with solid walls must have at least one cell. The most probable places of interference from the external network in each cell are measured using mobile communications means for frequency scanning to find free frequencies in all places where the mobile phones will be operated in the area of the cell. Subsequently, one of the free frequencies and a power level is selected for the base station of each cell. The base station is installed with preset parameters, and selected configuration data is transmitted to the base station. The station is then activated and the procedure is repeated for the next base station and cell. The stations are preferably configured in order so that the gateway cells are configured first, then the other cells on the ground floor second and the cells in the other floors last.

After the actual installation the network is preferably optimized so that the at least the following key aspects are in condition. The indoor network should not unnecessarily disturb the surrounding outdoor network, which can be avoided by using a sufficient number of indoor base stations with low power levels. However, the number of base stations should not be too high to avoid unnecessary costs. The number of sites can be optimized with intelligent trimming of base station parameters such as the power levels. If the configuration of the outdoor network is changed at a later time, the indoor network has to be checked to avoid conflicting frequencies after the change.

In one advantageous embodiment of the invention, the near neighbour relations of the indoor network are specified preliminarily during the BTS site location phase, and the near neighbour relations are adjusted as base stations are installed. If some base station locations are left installed, corresponding entries in the near neigbour list are removed.

In another advantageous embodiment of the invention, the near neighbour lists are created during the BTS installation phase. For example, the installation engineer can enter each newly installed BTS to the near neighbour list and define the near neighbour relations of the BTS after installation of the BTS by using the mobile communication means of the engineer.

The parameter sets described previously preferably correspond to different surroundings of a base station. For example, one parameter set may be intended for base stations at open offices and other open spaces and a second for locations surrounded by separate rooms. During the preplanning phase, one or more such parameter sets may be defined. Preferably, a parameter set identification is associated with each parameter sets, whereby at BTS installation the engineer only needs to select the desired identification without having to enter all of the various parameters.

Although the invention has been described previously using examples and terminology pertaining to a GSM network, the invention is not limited to any way to the GSM network only. The inventive installation method may for example be used with the UMTS system as well. Further, although the invention has been described using an indoor cellular system as an example, the inventive method may advantageously be used also in other types of surroundings. The inventive method is

especially advantageous when installing micro- and picocells, i.e. cells with a relatively small size, where simulation methods do not provide as reliable preplanning information as in the case of large macrocells.

In view of the foregoing description it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention. While a preferred embodiment of the invention has been described in detail, it should be apparent that many modifications and variations thereto are possible.